

"Preliminary Note on the Innervation of the Mammalian Heart." By L. C. WOOLDRIDGE, D.Sc., M.B., George Henry Lewes Student. Communicated by Dr. M. FOSTER, Sec. R.S. Received April 23, 1883.

The research was carried out in the Physiological Institute at Leipzig. The immediate object was to determine the function of nerves which are to be seen on the surface of the ventricles of the hearts of mammals. It was important to know their functions on the following grounds:—

In the frog, stimulation of the sinus produces stillstand of the heart. The inhibitory fibres have at any rate here a provisional ending.

On the other hand the result of stimulation of the ventricle may be regarded as a form of acceleration.

In the dog, the vagus and accelerans nerves act on different mechanisms (Baxt).

Having regard to these facts the possibility of the ventricle nerves being accelerator presented itself.

To know the function of these nerves was not only interesting, *per se*, but also as forming an appropriate introduction to the nearer investigation of the nervous mechanism of the mammalian heart.

The following observations on the accelerans will be first recorded:—

Hitherto in the dog, the experiments on the accelerans nerve have been carried out almost exclusively with that of the right side. It was more convenient in the present case to work with the left nerve (Ansa Vieusseni). The author has observed that in many cases stimulation of the left accelerans is without any influence on the rhythm of the heart; and that this was not due to accident, such as lowering of the temperature, was shown by the control stimulation of the right accelerans. This fact is not without importance for the remainder of the research, as will be seen.

Minimal electrical stimulation of the vagus overcomes completely the action of the accelerans, but the accelerans overcomes the normal slight tonic action of the vagus (Baxt). In an experiment of the author there existed, owing to stimulation of the medulla, a most powerful tonic vagus action. Thus—

Average of pulse beats before division of vagi...		8
“	“ after “	... 18

Yet stimulation of the accelerans overcame this and produced marked quickening. If during the stimulation of the accelerans a very small cardiac branch of vagus (in the thorax) were stimulated, it exerted its inhibitory influence, and overcame the accelerans, though it did not depress the pulse to the same degree that the tonic vagus action did. With our present knowledge, this experiment points to a difference between the stimulation of a nerve from its centre, and the electrical stimulation of its trunk.

The ventricular nerves are very numerous, but require in the dog the use of special methods, in order to be seen well; the author recommends strong carbolic acid for this purpose. These nerves form at any rate the greater part of the nervous connexion between the auricle and ventricle. They cannot be adequately stimulated after they have passed on to the ventricle, since the stimulus affects the heart itself too. This is more particularly the case for electrical stimulation. As

is well known, very slight stimulation with a Faradaic current destroys the activity of the ventricle by bringing about a peculiar condition of fibrillar contractions.

The author's procedure was as follows: The ventricular nerves pass on to the ventricle at definite points of the auricular ventricular boundary, where they are collected into larger trunks. He has observed that division of these trunks has no influence on the rhythm of the heart, nor does it in any way impair the action of the vagus or accelerans nerve. These ventricular nerves are therefore not essential to any of these processes.

The ventricular nerves are the continuation of certain definite cardiac nerves, which can be isolated in the thorax at a distance from the heart. When these cardiac nerves are stimulated, some of the ventricular nerves must be stimulated too. In particular, the majority of the nerves on the posterior surface of the heart, are derived from a trunk which arises either from the left vagus ganglion, or from some part of the *Ansa Vieusseni*. This nerve usually runs quite isolated to the heart. The result of stimulation of the peripheral end of this nerve are as follows:—

Out of 14 experiments, it exerted in 4 a vagus action, without any acceleration; in 2 an acceleratory action without any inhibitory; in 8 it had no influence on the rhythm. The nerve sometimes gives off obvious branches to the auricle; in some of the cases where no influence on the rhythm was produced, these had been cut away. Particular attention was given to this nerve, because it is easy to isolate, and because it certainly contains fibres which go on to the ventricle.

The author also stimulated the other cardiac branches, which are in obvious connexion with the ventricular nerves. Sometimes they produced inhibition, sometimes acceleration, but also in this case the division of the trunks which continue these nerves on to the ventricle did not produce any change in the result of their stimulation. The author from the above observations concludes that the ventricular nerves have no direct influence on the rhythm of the heart.

Stimulation of the central end of those cardiac nerves, which are continued on to the ventricle, is followed by marked reflex phenomena; and this fact, in conjunction with the negative result just recorded, leads the author to regard the ventricular nerves as being chiefly sensory, or more exactly, centripetal.

The reflex phenomena are, rise and fall of blood pressure, slowing and quickening of the pulse. On placing a small piece of blotting paper soaked in acetic acid on to the surface of the ventricle in the rabbit, a rise of blood pressure was observed; the acetic acid was moderately strong; a second application to the same part had no effect. On tearing through the nerve trunks from which the ven-

tricular nerves start, reflex movements of the animal (dog) were observed.

The reflex acceleration of the heart beat, to be obtained by central stimulation of the cardiac nerves, is marked, and is not due to change in blood pressure. The fact that sensory nerves go to the heart was shown long ago by Ludwig and Cyon's discovery of the depressor nerve in the rabbit.

In the dog a large nerve (or two smaller) runs from the left vagus ganglion and sometimes from the trunk, and ends chiefly between the coats of the aorta, giving occasionally a branch to the Arteria Pulmonalis. The peripheral stimulation of this nerve is without effect. The central stimulation produces slowing of the heart and fall of blood pressure; sometimes the slowing is followed by acceleration. The nerve is very sensitive to mechanical stimulation.

The extent and importance of the centripetal nerves which come from the heart and great vessels, is clearly shown in the author's experiments. Whether the ventricular nerves are solely centripetal or not has not been fully determined. It is rendered probable by the author's experiments, that both vagus and accelerans act on mechanisms in the auricles. In some cases the author has observed changes of blood pressure follow stimulation of the peripheral ends of nerves going direct to the heart, either without any change in the beat, or without a corresponding change. But his observations on this point are too few to draw definite conclusions. The mercurial manometer was used. The dogs were narcotized with opium, and then the brain divided through the pons, the object being to render the subsequent steps of opening the thorax painless, and still to preserve reflex actions.